

HYDROSIMULATICS INC
721 N. Capitol Avenue Suite 2, Lansing MI 48906
Email: admin@magnet4water.com
Phone: (517) 580-8215
Website: <https://www.magnet4water.net>



Addendum:

ALLEGAN COUNTY GROUNDWATER STUDY – PHASE 2:

Screening-Level Modeling, Risk Analysis, and Ranking

By: Zachary K. Curtis
Hydrosimulatics INC.

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Motivation

The Phase 2 study represents the first critical step for Allegan County toward managing its large number of point-sources (sites) of groundwater concern. The integration of numerous spatial datasets and groundwater modeling capabilities enabled characterizing in a relatively short time the potential for groundwater transport and risk to critical groundwater receptors. This information can be used to guide the next steps of management and investigation, which may involve incorporating human and environmental health perspectives and updating the risk ranking/priority lists, as well as refining the groundwater modeling as more data become available and management priorities evolve.

The sites of groundwater concern investigated in the Phase 2 analysis included: 237 Sites of Environmental Contamination (Part 201) downloaded August 2022 from the Environmental Mapper web application¹ maintained by the Department of Environment, Great Lakes, and Energy (EGLE); 46 historical or operational landfills or waste handlers (Part 105, Part 111) downloaded August 2022 from the Michigan Geographic Information System (GIS) data portal²; and five Per- and polyfluoroalkyl substances (PFAS) sites downloaded August 2022 from the EGLE’s MPART PFAS Geographic Information System³. Additionally, six “Open” (Active) LUST sites from the Environmental Mapper application were included in the analysis. Accounting for some duplication (i.e., a handful of sites are included in multiple datasets downloaded for this study), the total number of unique sites analyzed for the study was 289.

Objective and Scope

The purpose of this Addendum is to document the additional analysis completed by Hydrosimulatics to include the remaining 62 Open LUST sites in the countywide risk ranking portfolio. The same methodology and process applied to the original 289 sites of groundwater concern was used on the remaining LUST sites – see the Phase 2 final report “ALLEGAN COUNTY GROUNDWATER STUDY – PHASE 2: Screening-Level Modeling, Risk Analysis, and Ranking” submitted by Hydrosimulatics on March 14, 2023.

In particular, Hydrosimulatics performed the following tasks:

1. Delineate potential impact areas of the remaining LUST sites. This involved flow pattern delineation and forward “particle tracking” from source locations of assumed travel times of 2yr, 10yr, and 20yr.
2. Perform integrated overlay analysis of all remaining LUST sites. This involved “scoring” each site based on the proximity of the LUST site and its impact areas to critical groundwater receptors, including drinking water wells, non-drinking water wells, and surface water. This also involved assigning a “vulnerability” score to each site based on the aquifer vulnerability underlying the site (see Task 3 in the original Phase 2 study).

¹ 1 Accessible at: <https://www.mcgi.state.mi.us/environmentalmapper/#>

² Accessible at: <https://gis-michigan.opendata.arcgis.com/>

³ Accessible at: <https://egle.maps.arcgis.com/apps/webappviewer/index.html?id=bdec7880220d4ccf943aea13eba102db>

3. Update the risk ranking lists to include the remaining Open LUST sites, including the overall risk ranking, the drinking water ranking, the non-drinking water ranking, and the surface water ranking.
4. Document the results from particle tracking (plan-view maps of impact areas) and update the supplemental document: “Screening-level Modeling – Estimated Impact Areas of Site of Groundwater Concern”. This also involved creating GIS shapefiles of the updated portfolio of sites of groundwater concern that includes all Open LUST sites in Allegan County. The GIS shape files have been packaged into one file, so that if they are accessed by the public, the sites are easily found.

Updated Risk Ranking Results

Table 1 lists the total score and “subscores” (drinking water score, non-drinking water score, etc.) for each of the 351 sites analyzed in this study (including the additional 62 Open LUST sites, which are labeled in red font). They are ordered in terms of total score (highest to lowest).

Figure 1 shows a histogram of the total risk ranking scores. The average, minimum, and maximum total score assigned was 25.7, 0, and 71.1, respectively. The top 25 sites (in terms of highest score or highest risk) have scores of ≥ 40 , and the top 50 sites have scores of ≥ 43.7 . There are 58 sites that have a total score of ≤ 10 (very low risk). There is one site with a total score of zero (no risk).

Figure 2, Figure 3, Figure 4, and Figure 5 show the histograms for drinking water scores, non-drinking water scores, surface water scores, and aquifer vulnerability scores, respectively.

The average, minimum, and maximum drinking water score assigned was 41.0, 0, and 100, respectively. There are 48 sites with a drinking water score of ≥ 80 , 14 sites with a drinking water score of ≥ 90 or higher, and three sites with a score of 100. There are 126 sites with a drinking water score of ≤ 20 , and 52 sites that have a drinking water score of zero (no drinking water risk).

The average, minimum, and maximum non-drinking water score assigned was 15.3, 0, and 90, respectively. There are 7 sites with a non-drinking water score of ≥ 80 . There are 264 sites with a non-drinking water score of ≤ 20 , and 169 sites that have a non-drinking water score of zero (no non-drinking water risk).

The average, minimum, and maximum surface water score assigned was 41.2, 0, and 100, respectively. There are 23 sites with a surface water score of ≥ 80 , 11 sites with a score of ≥ 90 , and 1 site with a score of 100. There are 111 sites with a surface water score of ≤ 20 , and 42 sites that have a non-drinking water score of zero (no surface water risk).

The average, minimum, and maximum aquifer vulnerability score assigned was 0.7 (0.68), 0.2, and 1.0, respectively. There are 142 sites with a surface water score of ≥ 0.8 , 93 sites with a score of ≥ 0.9 , and 32 sites with a score of 1.0. There are 25 sites with a surface water score of ≤ 0.3 , and 4 sites that have an aquifer vulnerability score of 0.2.

Figure 6 presents a countywide map of the sites symbolized based on total score. Figure 7, Figure 8, Figure 9, and Figure 10 show the sites again symbolized based on total score for the northeast, southeast, southwest, and northwest quadrants of the county, respectively. Notable “visual hotspots” or clusters of sites with high or moderately high total risk scores include: in and around Wayland, in the northeast portion of the county; in and around Plainwell, in the southeastern corner of the county; in Allegan and southeast of the city; in the northern third of Hopkins Township, and north-northeast of Saugatuck.

Figure 11 shows a map of the sites symbolized based on drinking water score. Figure 12, Figure 13, Figure 14 show a map of the sites symbolized based on non-drinking water score, surface water score, and aquifer vulnerability score, respectively.

Hotspots of sites with high or moderately high drinking water scores largely reflect the spatial pattern seen in the total risk scores; notable areas include: in and around Wayland, in the northeast portion of the county; in and around Plainwell, in the southeastern corner of the county; in Allegan and around the city; and in and around Saugatuck and the Village of Douglas.

Notable “visual hotspots” or clusters of sites with high or moderately high non-drinking water scores include: in Wayland, in the northeast portion of the county; north of Plainwell and Otsego, in the southeastern corner of the county; in the northern third of Hopkins Township, in the western half of Ganges township, and north-northeast of Saugatuck and south of the Village of Douglas.

Notable “visual hotspots” or clusters of sites with high or moderately high surface water scores are not surprisingly focused along the Kalamazoo River in Plainwell, Otsego, Allegan, and along the Rabbit River (and its tributaries) in Wayland, Hopkins Township, Salem Township and Heath Township.

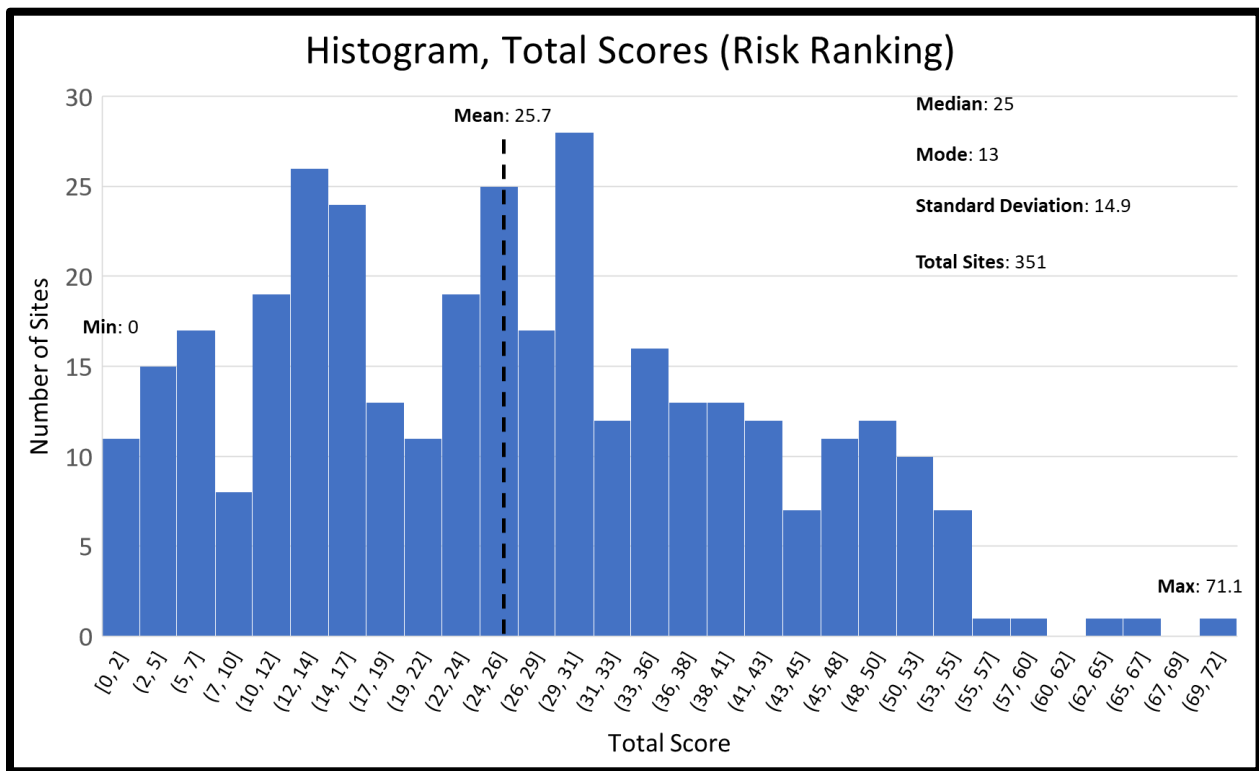


Figure 1: Histogram distribution of total scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

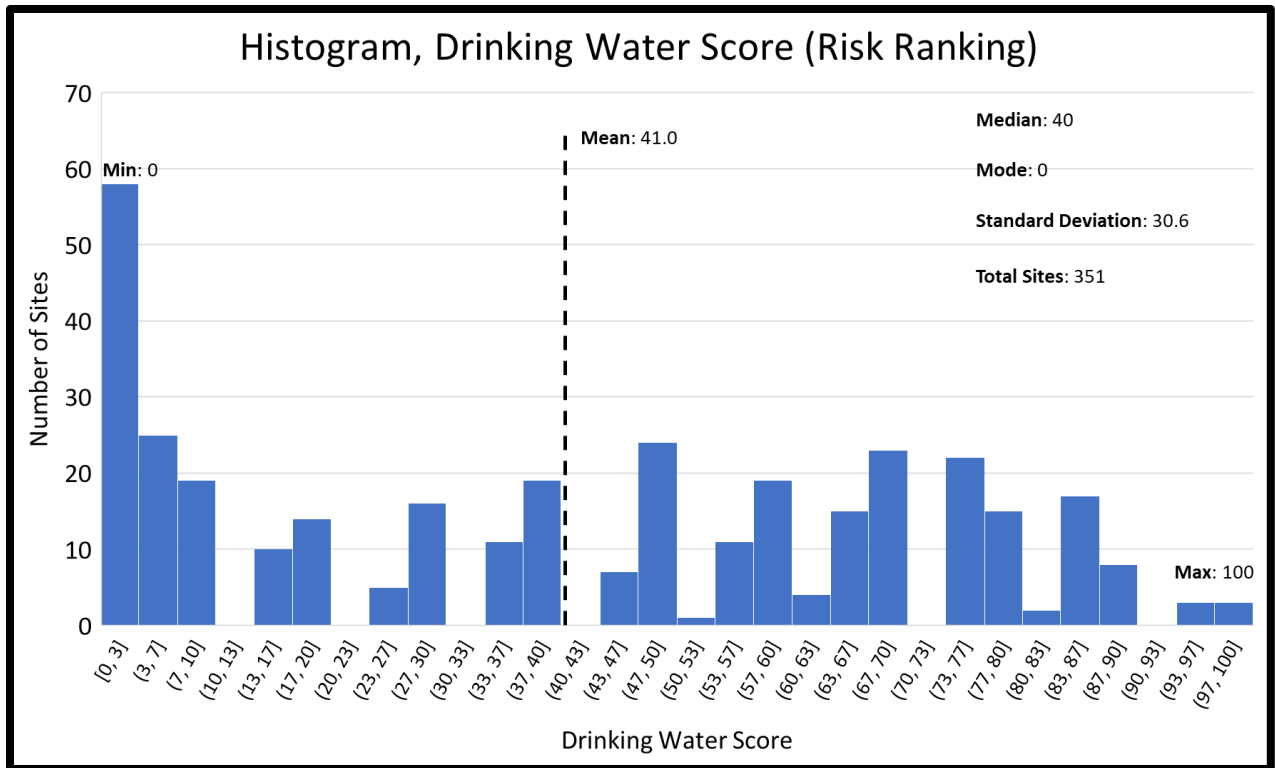


Figure 2: Histogram distribution of drinking water scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

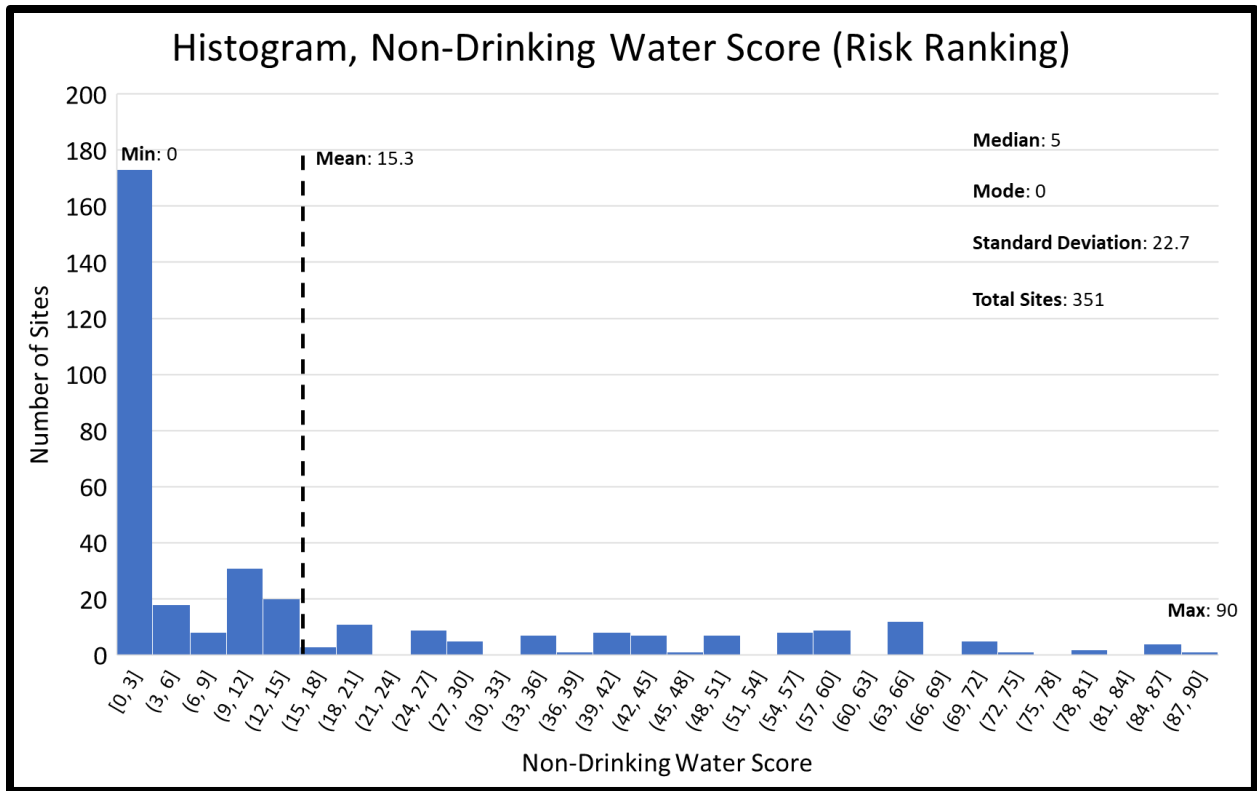


Figure 3: Histogram distribution of non-drinking water scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

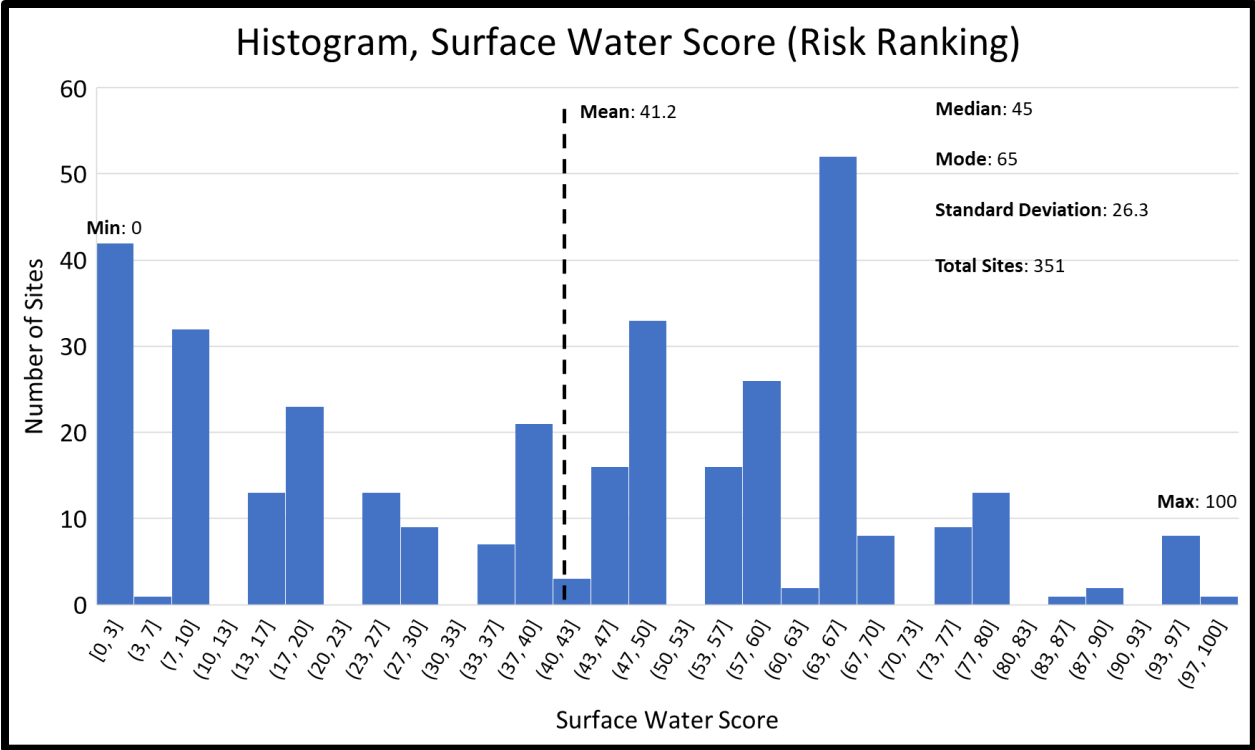


Figure 4: Histogram distribution of surface water scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

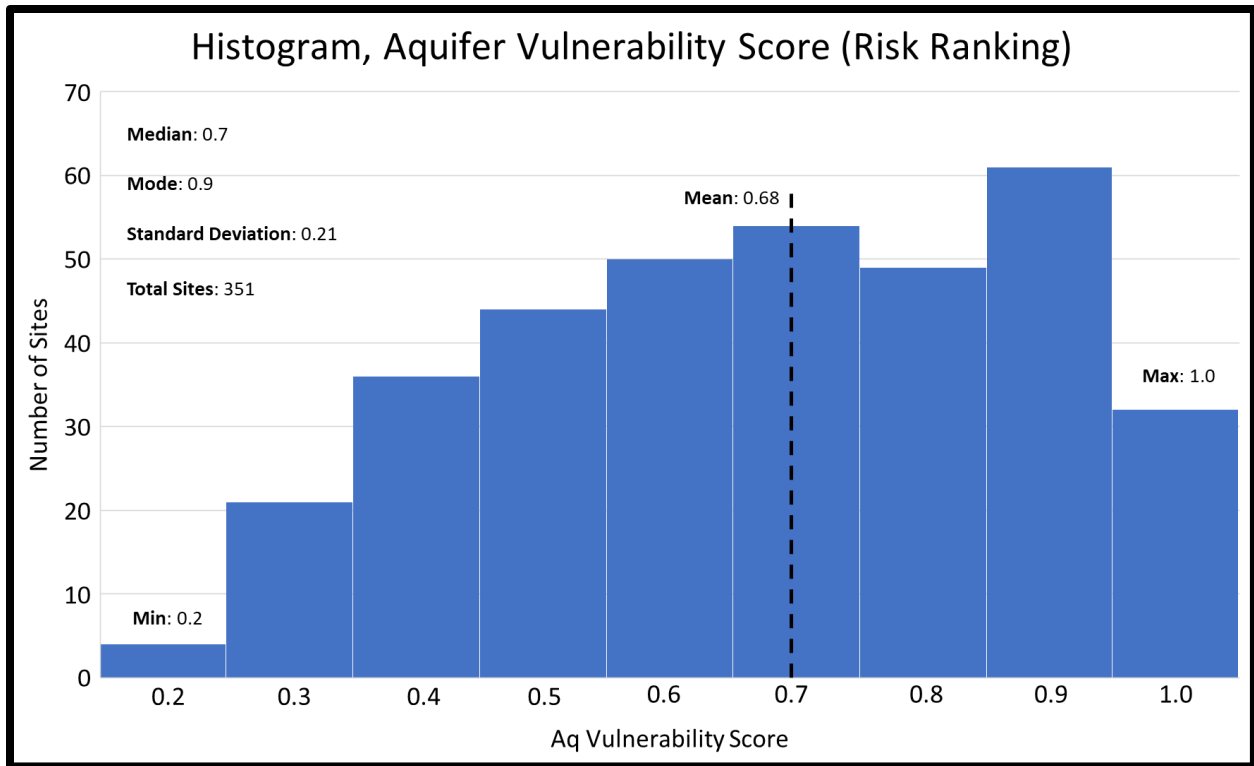


Figure 5: Histogram distribution of aquifer vulnerability scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

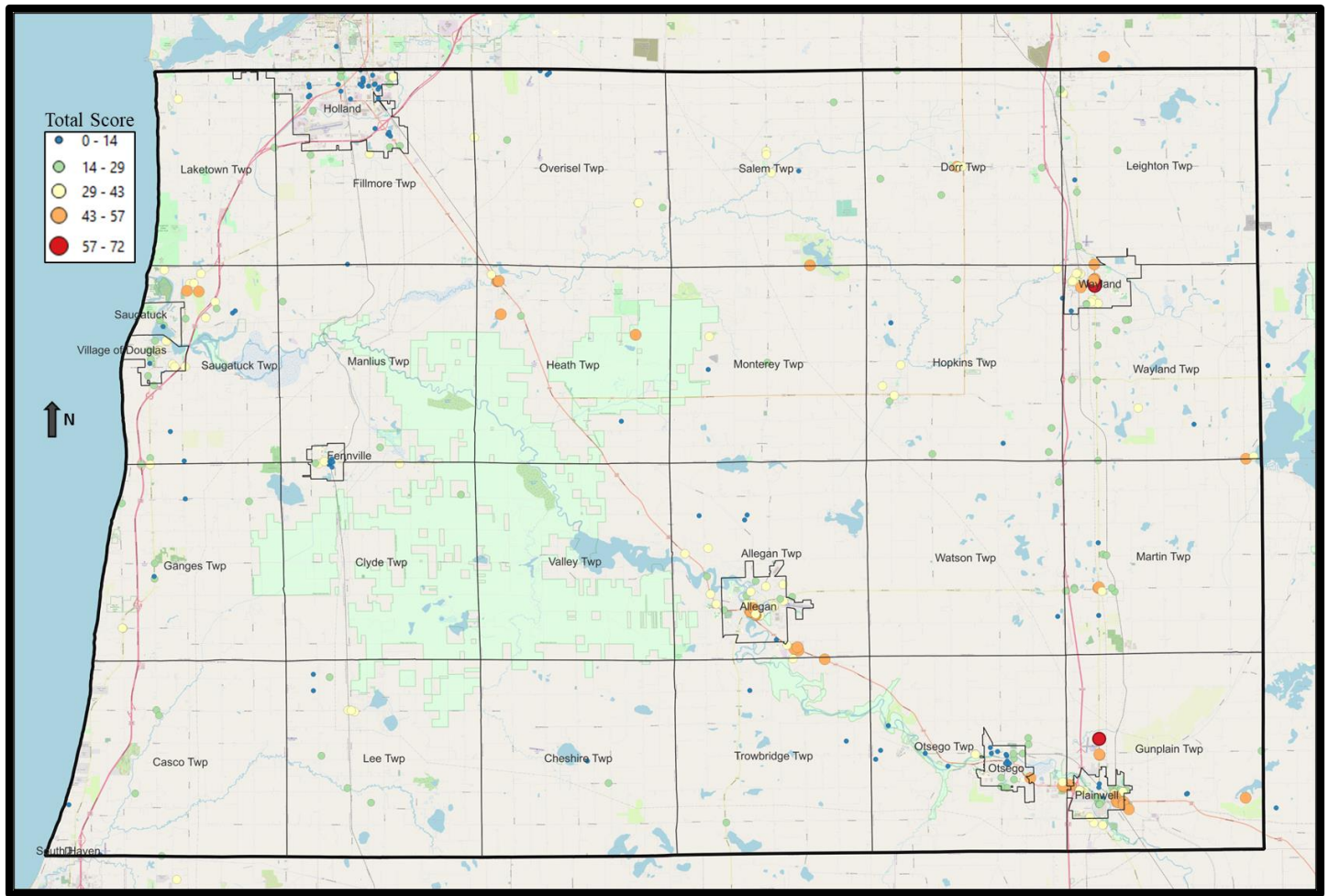


Figure 6: Map of total risk ranking scores for all 351 sites of groundwater concern analyzed in this study (including the additional 62 Open LUST sites).

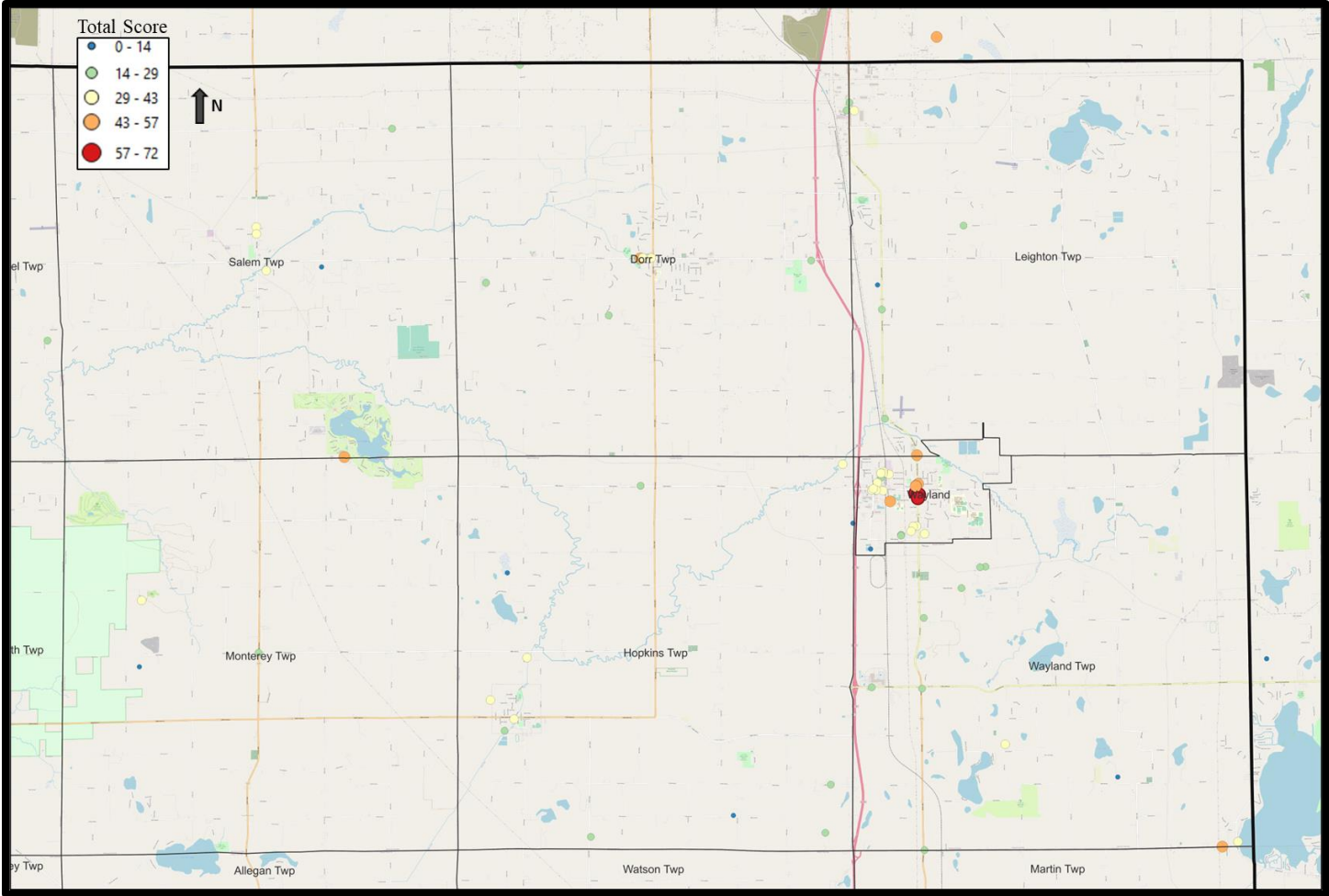


Figure 7: Map of total risk ranking scores for sites in the northeast quadrant of the county.

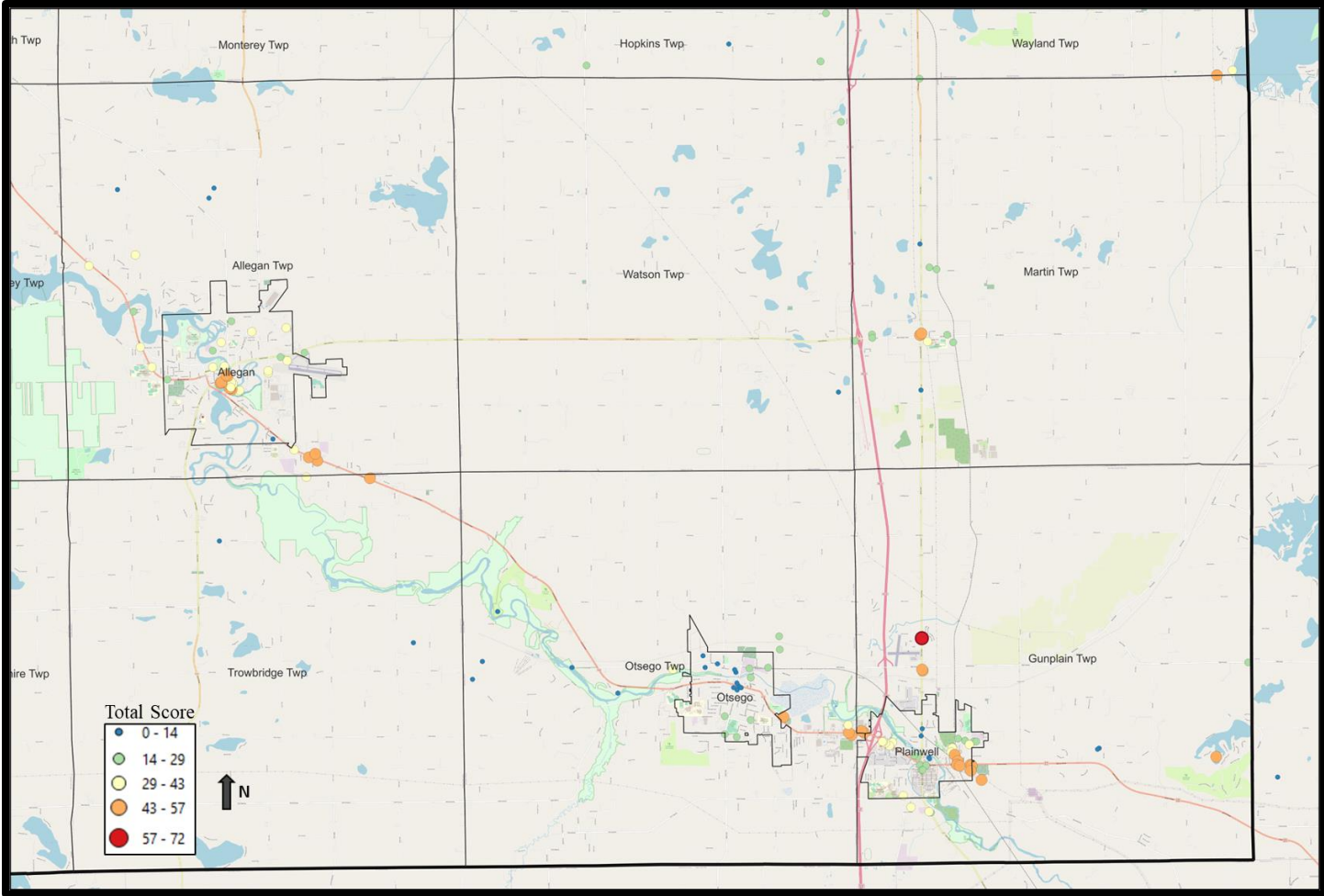


Figure 8: Map of total risk ranking scores for sites in the southeast quadrant of the county.

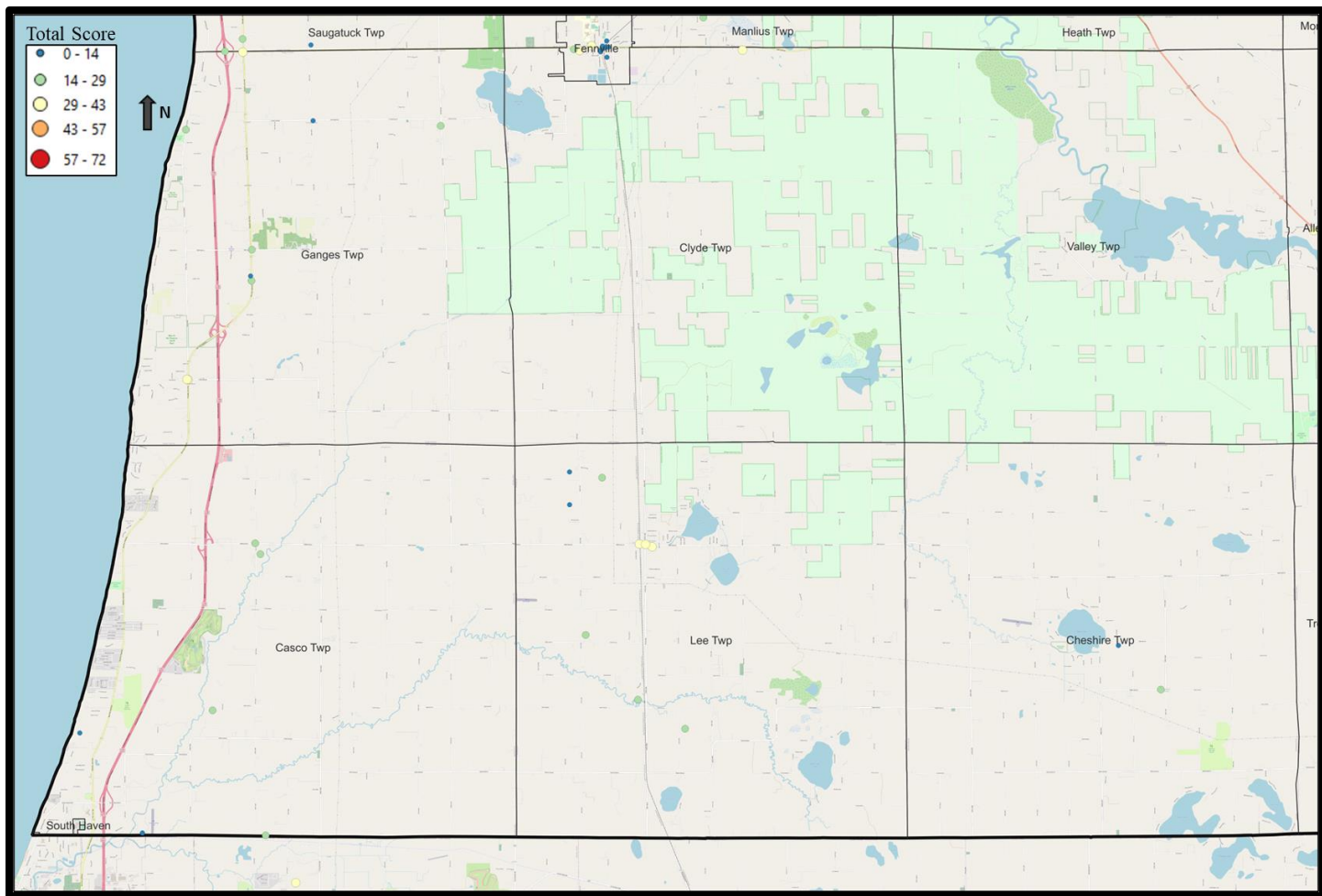


Figure 9: Map of total risk ranking scores for sites in the southwest quadrant of the county.

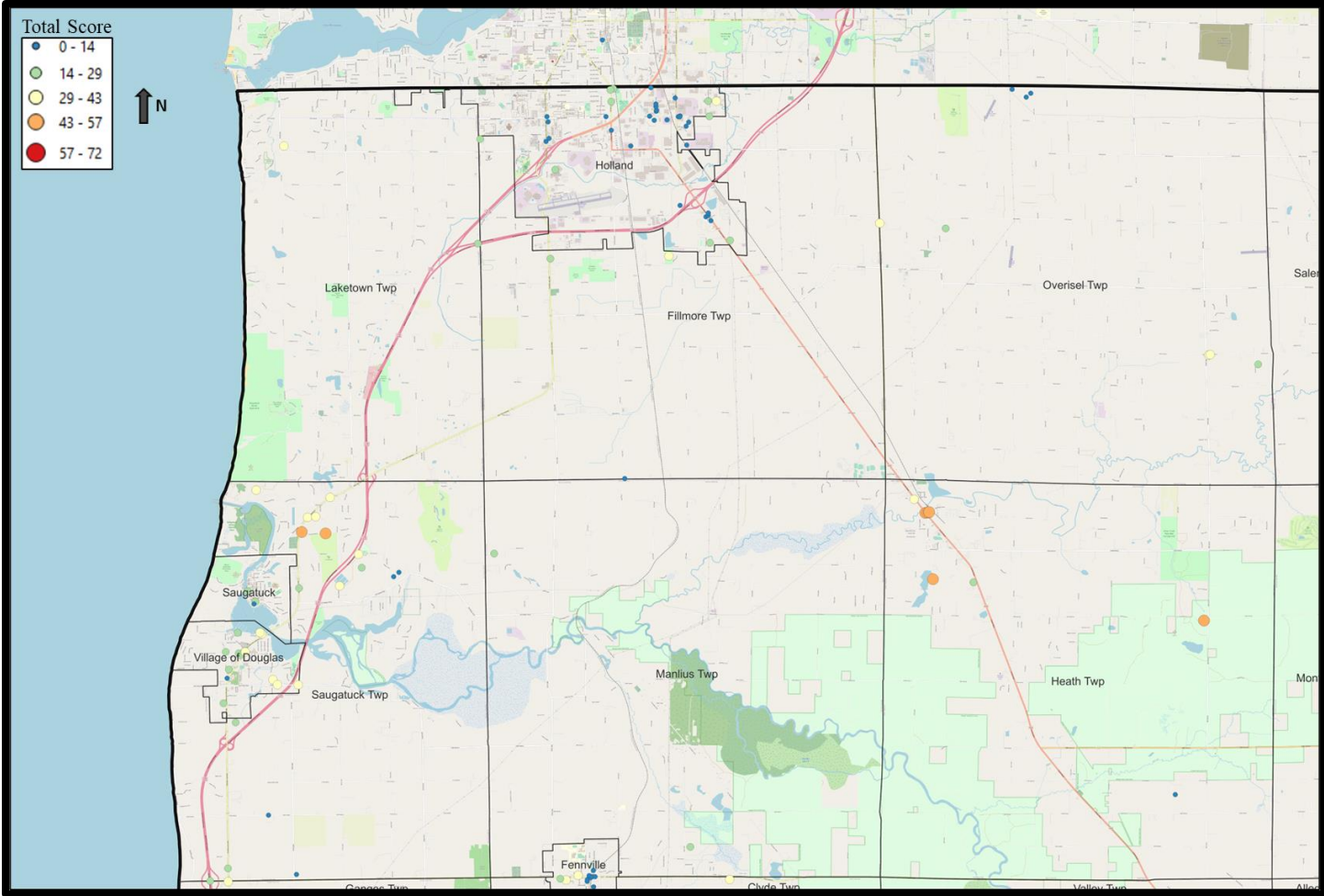


Figure 10: Map of total risk ranking scores for sites in the northwest quadrant of the county.

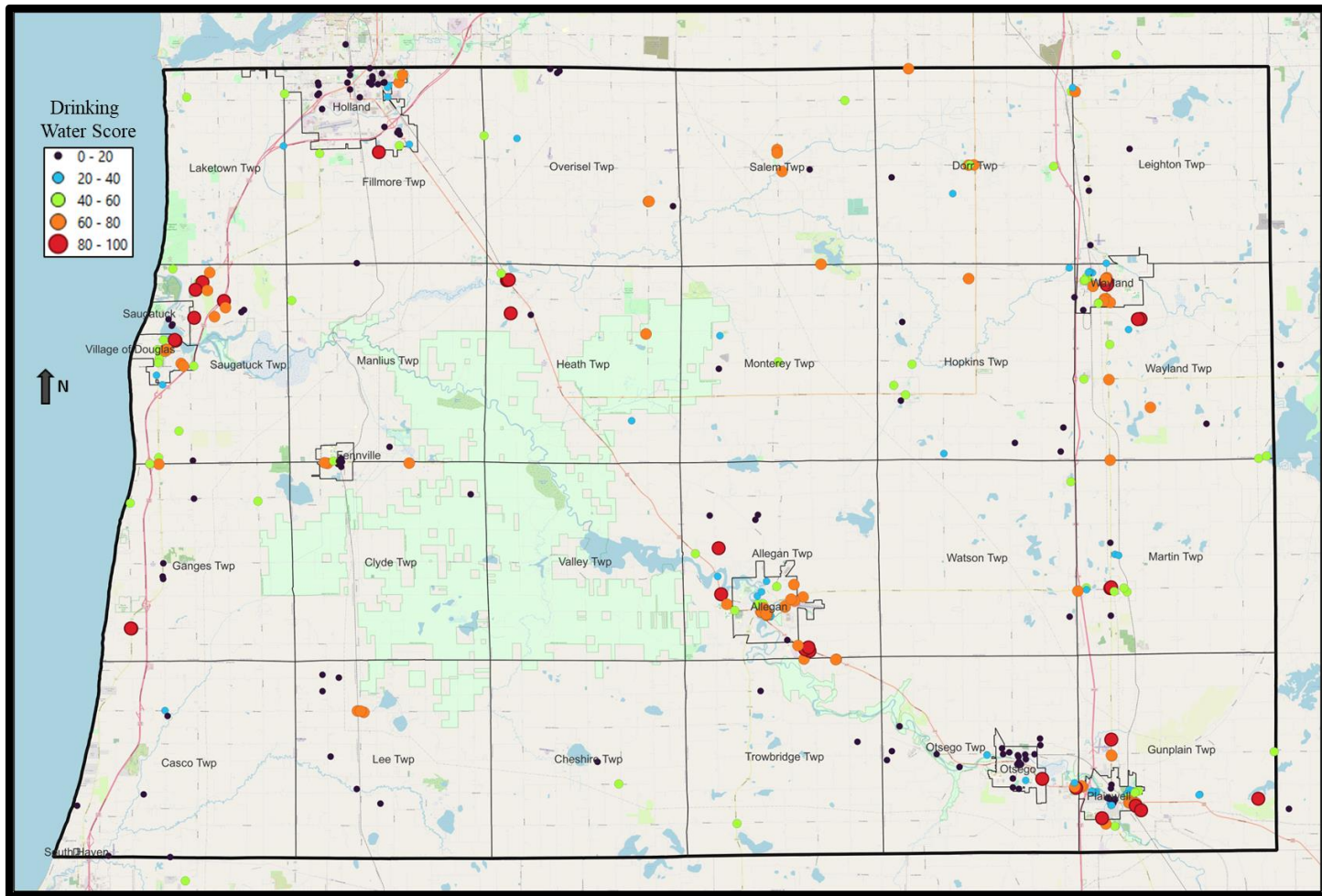


Figure 11: Map of drinking water scores for all 351 sites analyzed in this study (including the additional 62 Open LUST sites).

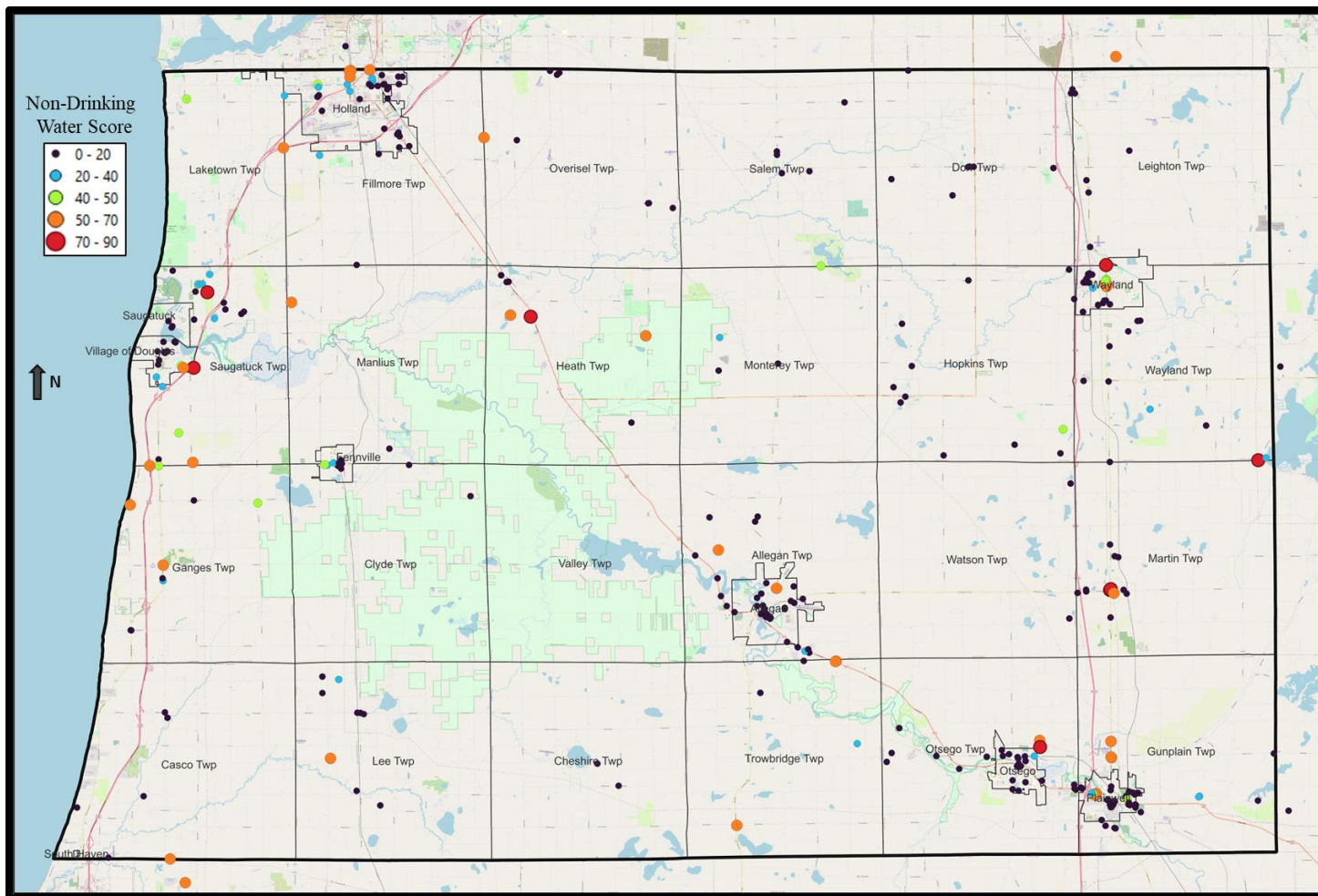


Figure 12: Map of non-drinking water scores for all 351 sites analyzed in this study (including the additional 62 Open LUST sites).

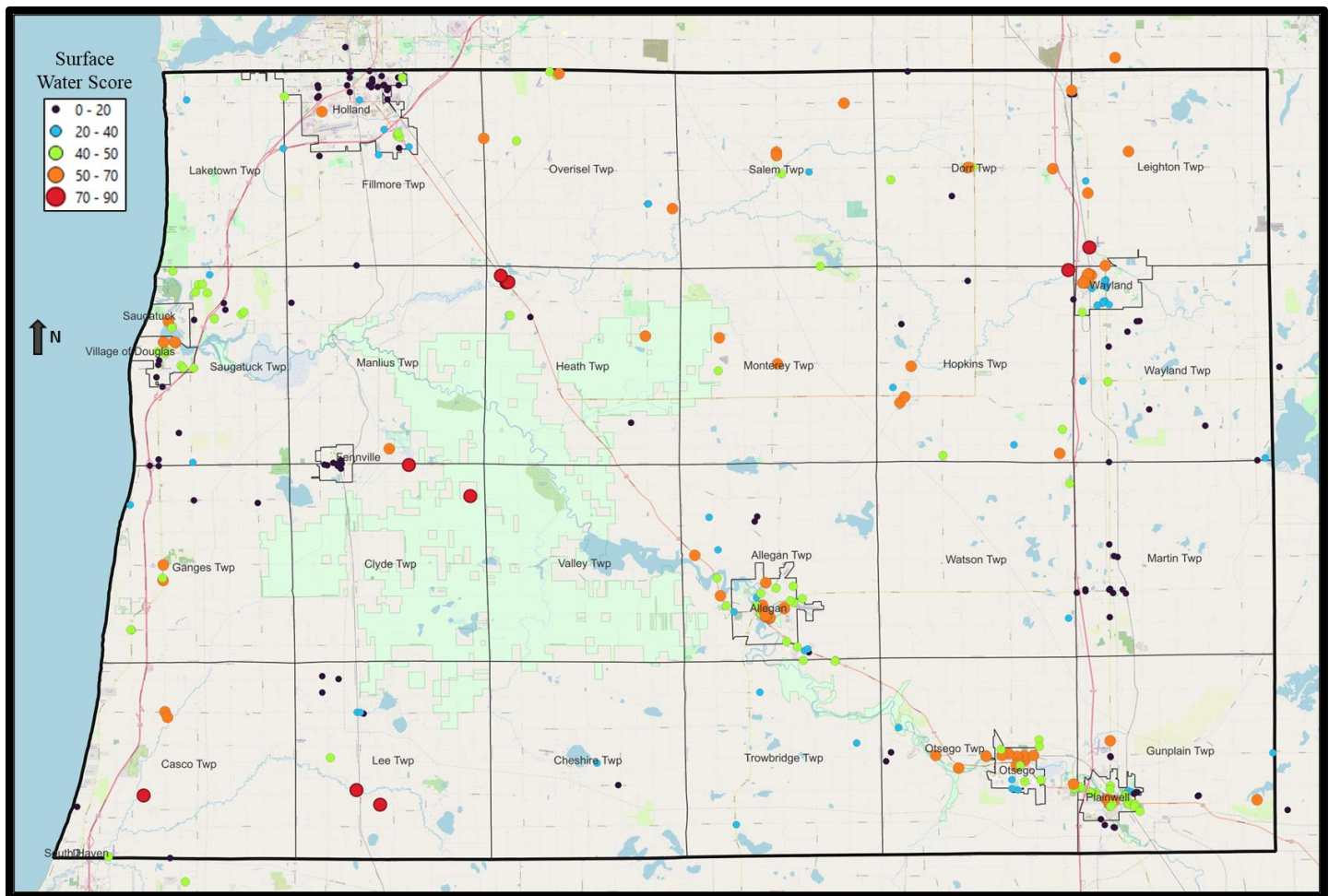


Figure 13: Map of surface water scores for all 351 sites analyzed in this study (including the additional 62 Open LUST sites).

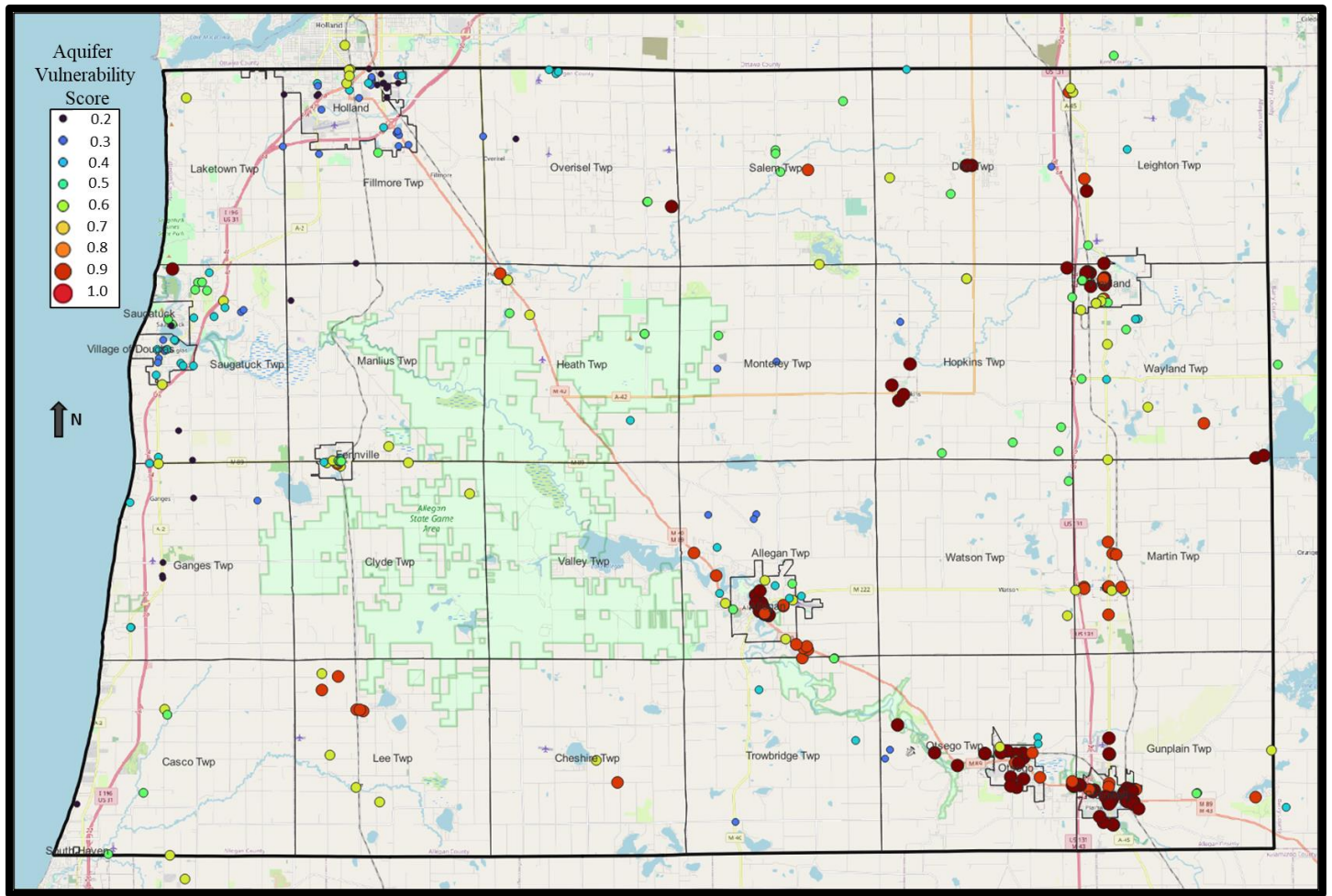


Figure 14: Map of aquifer vulnerability scores for all 351 sites analyzed in this study (including the additional 62 Open LUST sites).

Table 1: Total scores and “subscores” (drinking water scores, non-drinking water scores, etc.) for all 351 sites analyzed in this study (including the additional 62 Open LUST sites, which are labeled in **red font**). They are ordered in terms of total score (highest to lowest).

SiteID	Site Name	DW score	NDW Score	SW score	AQVul Score	Total Score
3000356	687 North 10th Street	90	60	75	0.9	71.7
3000306	203 South Main Street	85	70	40	0.9	65.15
00015681	Wayland Self Serve (LUST Site)	90	65	30	0.9	64.05
3000277	114 Pine Street	85	70	40	0.8	58.8
3000325	3603 N. Main Street	40	90	75	0.9	57.3
3000211	585 10th St. Plainwell	80	55	20	0.9	54.85
00011505	Ridderman Card -OP (LUST Site)	80	55	20	0.9	54.85
00015678	Martin (LUST Site)	85	85	0	0.8	54.4
3000360	712 East Bridge Street	75	15	60	1	54
3000367	798 E. Bridge Street Fmrly 760 E. Bridge	75	15	60	1	54
3000268	101 124th Avenue	60	85	20	0.9	53.95
3000265	150 North Main Street	75	45	40	0.9	53.9
00017433	Friendly 66 (Martin Pacific Pride) (LUST Site)	83	80	0	0.8	52.4
3000014	Angle Steel Div (Kewaunee Scientific)	70	17	60	1	52.1
3000421	243 Hubbard Street, Allegan	80	0	60	1	52
3000310	236 Hubbard Street	80	0	60	1	52
3000426	4634 4671 East Washington Street & 3501	85	15	95	0.7	51.9
00006437	Hamilton Farm Bureau Cooperative (LUST Site)	85	15	95	0.7	51.9
3000016	Section 25 Gun Plain Township	90	0	75	0.8	51
00042709	Former Wayland Motors Sales (LUST Site)	80	48	37	0.8	50.92
3000299	159 N. Main Street	80	45	40	0.8	50.8
3000283	1218 M-89 Highway	85	0	60	0.9	50.25
3000436	637 West Sycamore Street, Wayland	75	30	40	0.9	49.85
00015356	Sandy Pines Retail Center (LUST site)	80	45	60	0.7	49.45
Site 123	Otsego Township SLF	95	0	55	0.8	49
3000151	Boyce, Lelia Public Administrato	70	65	80	0.6	48.7
3000152	Boyce, Lelia Public Admins 1	70	65	80	0.6	48.7
3000285	124 Locust Street	85	0	50	0.9	48.25
3000004	Allegan Metal Finishing	90	30	25	0.8	48.2
3000073	Conrail-Plainwell	60	45	45	0.9	48.15
3000416	1175 M-89, Plainwell, MI 49080	80	0	60	0.9	48
3000281	1185 M-89 Highway	80	0	60	0.9	48

3000407	1227 M-89, Plainwell MI 49080	80	0	60	0.9	48
3000439	6494 Clearbrook Drive & 6402 and 6500 13	75	75	60	0.6	48
Site 1990	Heath Twp Landfill	90	60	50	0.6	47.8
3000384	East 1/2 of SE 1/4 Section 29	85	0	45	0.9	47.25
3000324	3506 M-40	85	15	95	0.6	47.2
3000424	4645 4670 Washington Street & 4621 135th	85	15	95	0.6	47.2
3000270	105-113 Brady Street	68	0	65	1	47
3000423	101 Brady Street, Allegan	68	0	65	1	47
3000272	111 Hubbard Street	68	0	65	1	47
3000302	1840 142nd Avenue	65	0	70	1	46.5
3000379	954 E. Bridge St. & 121 Locust St.	75	7	50	0.9	45.64
3000378	954 East Bridge Street	75	7	50	0.9	45.64
3000271	110 Water Street (portion of)	65	0	65	1	45.5
3000288	1258, 1260 Lincoln Road & Village EMH Pk	100	5	20	0.8	45.2
3000287	1255 Lincoln Road	85	20	30	0.8	44.8
3000333	406 Water Street	62	0	65	1	44
00008231	Mr Steven K Angle (LUST Site)	62	0	65	1	44
Site 762	Pease Avenue Pictures (site and WHPAs in Ottawa County)	60	65	70	0.6	43.7
3000282	1187 Lincoln Road (Trowbridge Twp)	70	70	50	0.6	43.6
3000239	North Pointe Plaza	95	20	55	0.6	43.1
3000340	558, 520, and 512 Water Street	60	0	65	1	43
3000029	Res Wells Lincoln Rd	65	70	50	0.6	42.1
00039997	Landman Sales Inc (LUST Site)	60	25	40	0.9	41.75
00009400	Wesco #9 (LUST site)	30	55	50	1	41.5
3000018	MDOT Fennville	70	0	85	0.7	41.5
3000350	6530 Sanctuary Way	90	25	50	0.6	41.5
00019008	Fifelski Service Station (LUST site)	65	0	60	0.9	41.25
3000319	324 Eastern Avenue	70	0	65	0.8	41
3000318	320 Eastern Avenue	70	0	65	0.8	41
3000382	A portion of Parcels 03440-030-008-00 &	60	0	70	0.9	41
3000201	310 Water Street	62	0	65	0.9	40.9
Site 95	Allegan Township Dump	95	60	40	0.5	40.75
3000261	Allegan (554) Street	28	55	50	1	40.5
3000267	100 Monroe Street	55	0	65	1	40.5
50005597	City of Allegan (LUST site)	68	0	65	0.8	40.2
00042506	Philly LLC (LUST site)	80	15	45	0.7	40.15
3000037	Jersey Street Plainwell	85	7	0	0.9	40.14

MID-006-016-190	Allegan Metal Finishing	75	0	50	0.8	40
3000036	International Harvester	100	20	60	0.5	40
50002085	Glenn Country Store (LUST Site)	100	20	60	0.5	40
Site 333	Geneva Twp Dump (in Van Buren County)	55	55	45	0.7	39.8
3000320	326 Water Street	65	0	65	0.8	39
00034666	S P Industries (LUST Site)	50	0	70	1	39
3000370	848, 856, & 858 S. Main Street	75	10	30	0.8	38.4
3000294	1307 Lincoln Road	65	10	50	0.8	38.4
3000039	136th & 12th	40	0	100	0.9	38
00042483	Former Hamilton Vet Clinic (LUST site)	50	0	90	0.8	38
3000200	300 Water St.	62	0	65	0.8	37.8
3000241	Lincoln (1600) Road, LLC	90	15	65	0.5	37.75
00007390	Allegan Fire Department (LUST Site)	55	0	50	1	37.5
00002804	Burnips Shell Station (LUST site)	75	7	68	0.6	37.36
3000172	Blue Star & M-89	70	50	10	0.7	37
00010223	AI's Total (LUST Site)	80	0	25	0.8	37
3000335	4302 30th Street	75	7	65	0.6	36.76
3000438	6784-6874 Wiley Road, Douglas	60	85	45	0.5	36.75
3000244	Superior St (1112) W., Wayland	60	15	80	0.6	36.7
3000383	Applewood Estates, Lots 3 & 4	75	40	10	0.7	36.65
00006446	Branch Maintenance Garage (LUST Site)	65	55	57	0.5	35.9
00017349	Wayland Shell (LUST Site)	60	10	80	0.6	35.8
00000605	Speedway #3578 (LUST site)	60	10	80	0.6	35.8
3000396	Wiley Road (Vacant Land (V/L))	65	50	60	0.5	35.75
3000349	641 W. Elm Street	40	10	75	0.9	35.7
3000346	623 W. Allegan Street	30	45	50	0.9	35.65
3000249	700 Grand Street, Allegan	70	0	55	0.7	35.5
3000052	Bloomfield Res Well	75	5	0	0.9	35.1
00016911	Pullman Marathon (former) (LUST Site)	75	0	25	0.8	35
00004529	Dorr Standard Service (LUST site)	50	0	62	0.9	34.9
3000264	1134 West Superior Street	55	12	80	0.6	34.66
Site 125	Salem Township Dump	75	0	60	0.6	34.5
3000410	4612 66th Street, Holland MI 49423	45	50	40	0.7	34.25
3000392	Swing Bridge (50,60,70,80,90) Ln & Kewat	85	0	65	0.5	34.25
3000393	Union Street & Blue Star Highway	85	0	65	0.5	34.25
3000007	Exit 41 LF	85	10	10	0.7	33.85
3000390	Singapore Dunes 320-Acres Vacant Parcel	50	0	55	0.9	33.5

3000237	Wayland Recycling, Inc.	40	0	77	0.9	33.4
00040697	Wayland Recycling Inc (LUST Site)	40	0	77	0.9	33.4
3000344	609 & 611 N. Eastern Avenue	65	15	55	0.6	33.2
Site 131	Bruce Girke; J & J Tires	35	40	75	0.6	32.7
3000369	844 S. Main Street	70	10	30	0.7	32.6
3000358	700 North Main Street	60	60	43	0.5	32.6
3000163	Pullman Road at 109th Avenue	70	0	20	0.8	32
MID-980-588-495	Bush Oil Company	45	0	80	0.7	31.75
Site 130	Wayland Township Dump	70	25	10	0.7	31.75
MID-092-947-928	Drug & Laboratory Disposal, Inc.	35	17	45	1	31.6
Site108	Fillmore Twp dump	85	0	30	0.6	31.5
3000351	6541 Blue Star Hwy Vacant Hooten Inn Pro	60	25	45	0.6	31.5
3000362	736 West Elm Street	40	0	65	0.9	31
3000331	400 Broad Street	35	15	45	1	31
3000002	A 1 Disposal Corp Plainwell	35	15	45	1	31
3000260	106th (1754) Avenue	40	0	65	0.9	31
3000301	1754 106th Avenue	40	0	65	0.9	31
10593	Rockwell International Corporation (PFAS site)	30	20	60	0.9	30.9
3000303	1846 Lincoln Road	45	0	63	0.8	30.6
3000011	Hughes Engraving	50	15	20	0.9	30.55
3000391	Southwest 1/4 of Sec 28, T2N, R13W City	35	0	65	1	30.5
3000427	665 Allegan Street, Plainwell	30	35	50	0.8	30.4
00034193	Kalamazoo Lk Sewer & Water Auth (LUST Site)	70	25	45	0.5	30.25
3000336	4346 48th Street	50	60	65	0.4	30.2
00039100	Saugatuck Campground (LUST Site)	75	35	30	0.5	30
3000371	858 S. Main Street (behind)	65	0	35	0.7	29.75
3000202	Neo-Tech/IST Warehouse	53	7	20	0.9	29.74
50002327	Metropolitan Title Office (LUST Site)	80	0	48	0.5	29.6
3000337	4651 & 4655 South Division Street	70	5	20	0.7	29.55
3000313	2811 24th Street	50	0	35	0.9	29.5
00004515	Fennville Shell Mart (LUST Site)	60	40	0	0.7	29.4
Site 129	Wayland City Dump	75	10	25	0.6	29.3
12250	Admiral Petroleum #174 (LUST site)	30	30	50	0.8	29.2
00001111	Martin Public School (LUST Site)	50	55	0	0.7	29.05
3000381	960 Productions Court	80	0	45	0.5	29

3000284	1227 M-89 Hwy Home Depot - Plainwell	40	0	65	0.8	29
3000257	Texaco Gas Station (Douglas)	80	0	45	0.5	29
3000432	3784 140th Avenue, Hamilton, MI 49418	70	5	35	0.6	28.9
3000431	3776 140th Avenue, Hamilton, MI 49419	70	5	35	0.6	28.9
3000343	5 Mill District Road	35	0	65	0.9	28.75
00002991	Martin Marathon (LUST Site)	75	2	10	0.7	28.67
00039406	Lake Park Trailer Resort (LUST Site)	55	65	25	0.5	28.5
00017374	Allegan Service Center (LUST Site)	70	0	55	0.5	28.5
3000286	124th Ave (M-89) & I-196 (US-31) Highway	60	50	50	0.4	28
00017345	Bradley Express Stop #335 (LUST site)	65	5	55	0.5	28
3000403	946 Industrial Parkway, Plainwell, MI 49	50	5	20	0.9	27.85
3000321	3292 Lincoln Road	20	80	20	0.7	27.8
3000345	610 South Platt Street	35	0	50	1	27.5
3000347	637 West Main Street	75	45	10	0.5	27.5
3000222	58th Street and 106th Ave Dump	5	70	55	0.7	27.45
3000207	Allegan, City of SW1/4 S28 2N13W	35	0	65	0.8	27
3000323	3387 Eagle Drive	40	0	55	0.8	27
00015971	Plainwell Clark (LUST Site)	30	0	60	1	27
00008110	Gless Service (LUST Site)	30	0	60	1	27
3000250	2870 116th Avenue, Allegan	70	0	47	0.5	26.9
00005611	Ben Knoper & Sons Roofing Co Inc (LUST site)	25	10	80	0.7	26.85
00034657	New Salem Grocery Inc (LUST site)	45	0	65	0.6	26.5
3000443	155 10th Street, Plainwell	40	15	20	0.9	26.05
3000440	931 Industrial Parkway, Plainwell	35	7	40	0.9	25.64
3000305	1 Glass Street	30	15	40	0.9	25.55
3000420	119 West Bridge Street, Plainwell	25	0	65	1	25.5
3000322	3295 Blue Star Highway	90	0	15	0.5	25.5
3000405	946 Industrial Parkway	50	5	20	0.8	25.2
3000441	216 Saint Peters Drive, Douglas	55	10	65	0.4	25.2
00035825	Merson Trading Post (LUST Site)	55	60	35	0.4	25.2
3000387	Part of S1/2, N1/2, NE1/4, S7, T3N, R11W	50	0	38	0.7	25.1
3000063	Acorn St Industrial Park	30	7	40	1	25.1
3000298	14 Ferry Street	60	10	43	0.5	25.1

3000286	124th Ave (M-89) & I-196 (US-31) Highway	55	55	15	0.5	25
00018439	Stop Shop and Roll (LUST Site)	60	0	65	0.4	25
00001551	Carter Automotive (LUST Site)	25	0	80	0.7	24.75
3000338	4652 Division Avenue	50	3	20	0.8	24.72
3000348	640 River Street	30	5	65	0.7	24.55
3000126	Midway Packing Company	50	0	35	0.7	24.5
Site 126	Spring Water CampGround	45	0	55	0.6	24.5
3000253	Hilliards General Store	65	0	7	0.7	24.15
3000437	999 124th Avenue, Shelbyville	65	0	7	0.7	24.15
00016276	Fred J Holbrook (LUST site)	65	0	7	0.7	24.15
3000295	1322-1326 142nd Avenue	55	0	65	0.4	24
3000316	309 Clark Street	20	0	75	0.9	24
17354	Pioneer Market (LUST site)	55	0	10	0.8	24
3000315	294 W. Center Street	75	0	45	0.4	24
Site 120	Menasha Corporation	0	85	55	0.5	23.75
3000329	3717 Division Avenue	15	0	95	0.6	23.5
50001810	Douglas Amoco 28876 (LUST Site)	75	0	42	0.4	23.4
Site 96	Bloks Refuse Service SLF	40	35	10	0.7	23.35
3000430	211 North Main Street, Plainwell, MI 490	20	0	65	1	23
3000292	1291 Lincoln Road	50	0	40	0.6	23
3000230	315 Fulton Street	20	0	70	0.9	23
3000355	6797 118th Avenue	10	60	80	0.3	22.9
Site 135	Castleton-Maple Grove Dump	5	10	95	0.7	22.85
00017434	Wykstra Oil Co., Inc. (LUST Site)	45	20	0	0.8	22.8
Site 91	Sunrise Sanitary Landfill	83	0	10	0.5	22.75
Site 92	Exit 41 SLF	70	15	15	0.5	22.75
3000278	1150 129th Avenue	50	15	25	0.6	22.7
3000290	1267 126th Avenue	5	50	60	0.6	22.5
0009832	Doster Country Store (LUST site)	50	0	25	0.7	22.5
3000153	Geib Oil Company (00015972)	50	10	0	0.8	22.4
3000215	MGP Otsego - MGU	0	35	70	0.8	22.4
3000212	Plainwell Paper Mill	20	0	65	0.9	22
3000422	140 East Bridge Street, Plainwell, MI 49	20	0	60	1	22
3000023	Pilgrim Farms Pickle Plant	15	0	70	1	21.5
3000031	Sunrise LF	85	0	0	0.5	21.25
3000332	4066 & 4070 Division Street Wayland	10	5	75	0.9	20.85
3000406	977 118th Avenue, Martin MI 49070	40	20	0	0.8	20.8
3000259	Menasha Corp Landfill	0	65	55	0.5	20.75

3000021	Millies Industrial Painting	60	30	45	0.3	20.7
3000398	Transcendia	50	15	0	0.7	20.65
3000231	977 118th Avenue	40	18	0	0.8	20.32
3000414	Lalli Brothers Express LTD LSE	40	60	25	0.4	20.2
Site 107	Fennville City dump	10	5	75	0.7	19.55
3000009	Goodale Facility Wayland	50	0	10	0.7	19.5
Site 117	Lee Twp Dump	0	0	95	0.7	19
3000413	Paul Platschorre Residence	30	0	50	0.6	19
Site 98	Casco Township Dump	0	0	95	0.6	19
3000314	2948 Blue Star Highway	40	40	15	0.5	19
3000327	360 Water Street	20	0	65	0.6	19
00015972	Geib Oil Co (LUST site)	40	10	0	0.8	18.4
00004105	Peter J. Parbel Iii (LUST site)	65	0	10	0.5	18.25
3000022	Parker Hannifin Corporation	20	0	40	1	18
Site 100	Clyde Manlius & Ganges Trash	0	0	90	0.7	18
3000245	Amsink Property	10	35	65	0.3	17.65
3000312	2438 Blue Star Highway	50	20	10	0.5	17.5
00018858	Fleming Brothers Oil Co (LUST Site)	5	0	80	0.6	17.5
3000219	Baseline Road Pesticide Barn	10	65	0	0.7	17.15
Site 97	Brown Brothers Landfill	50	65	15	0.3	16.35
Site 124	Overisel TWP Dump	35	10	50	0.3	16.15
3000330	394 South 16th Street	15	5	40	0.9	16.1
3000434	864 Productions Place, Holland	60	0	20	0.4	16
Site 105	Dorr Township Dump	40	0	20	0.6	16
3000304	1895 M-40 Highway	40	15	30	0.4	15.8
3000019	Menasha Corp	0	10	65	0.9	15.7
70000514	Lincoln Avenue Area Groundwater	0	65	10	0.7	15.65
3000442	788 Lincoln Avenue, Holland	0	65	10	0.7	15.65
00019273	The Voss Boys (LUST Site)	0	65	10	0.7	15.65
3000334	4277 1/2 Blue Star Highway	50	30	10	0.4	15.6
3000297	143rd Avenue Leighton Township	10	0	65	0.5	15.5
3000269	1035 E. 40th Street	75	0	20	0.3	15.25
3000400	Dutch Developers, LLC	50	10	20	0.4	15.2
3000300	160 South Washington Road	10	10	40	0.9	15.2
3000293	1300 & 1400 S. Washington Avenue	0	0	75	0.4	15
3000307	2180 62nd Street	45	50	0	0.4	15
3000032	Village of Douglas Contamination	60	0	15	0.4	15
3000309	236 Culver Street	20	0	45	0.6	15
3000251	Lower Scott Lake Containment Site	5	40	15	0.8	14.6
Site 1992	Balfoort Demolition Site (spelling ??)	10	0	55	0.7	14.5
3000374	868 132nd Street	35	0	20	0.6	14.5

3000291	1269 124th Avenue	5	0	65	0.6	14.5
Site 122	Otsego City LF	0	5	65	0.9	14.35
00010682	Rieth-riley Construction Co Inc (LUST site)	10	20	25	0.8	13.8
Site 90	Gun Plain Township & Plainwell City Landfill	30	25	0	0.6	13.5
3000057	Gun Plain Township Landfill	30	25	0	0.6	13.5
Site 127	Trowbridge Township Dump	5	40	30	0.5	13.25
Site 1793	Deyoung Landfill (PFAS site)	0	0	65	0.5	13
3000248	Smith Estate 2 and Tank Battery	15	0	35	0.8	13
3000429	201 Bannister Street, Plainwell, MI 4908	0	0	65	1	13
3000389	RR Spur Btwn N. Anderson & Kalamazoo Riv	0	0	65	0.9	13
3000311	241 & 243 North Farmer Street	0	0	65	0.9	13
3000433	132 Helen Avenue, Otsego, MI 49078	0	0	65	0.9	13
3000279	115 E. Allegan Street	0	0	65	0.7	13
3000275	113 North Farmer Street	0	0	65	0.7	13
3000401	Ostego, LLC	0	0	65	0.8	13
3000328	363 West River Street	0	0	65	0.9	13
3000262	Rock-Tenn Otsego Mill	0	0	65	0.9	13
3000428	519 19th Street, Otsego, MI 49078	0	0	65	0.9	13
3000417	2063 Covault Ln at Kalamazoo River	0	0	65	0.9	13
00042503	Kalico Kitchen Ltd (LUST Site)	55	0	10	0.4	13
00005116	Otsego (LUST site), 134 E ALLEGAN ST	2	10	50	0.7	12.8
50002605	Culver St Site (LUST Site)	17	0	50	0.3	12.55
3000053	Res Well Ottogan	5	0	55	0.5	12.25
Site 101	Deyoung Refuse Removal	0	0	60	0.5	12
3000256	Otsego Area Study	0	0	60	0.8	12
Site 121	Monterey Twonship Dump	5	0	55	0.4	12
00013325	Watervliet Marathon LLC (LUST Site)	0	0	60	0.9	12
00004932	R & H Petroleum Inc (LUST Site)	0	0	60	0.9	12
Site 1993	William Kelly Disposal Area	3	5	50	0.6	11.8
50002096	Healthiatry Center (LUST site)	5	50	15	0.5	11.75
00041959	Elinor Amsink and Jerry Amsink (LUST Site)	10	0	50	0.3	11.5
3000221	Saugatuck Township Contamination	0	10	50	0.4	11.2
3000081	Gleason Road Res Well	0	10	50	0.4	11.2
00009932	Gra-bell Truck Line Inc (LUST Site)	0	0	55	0.4	11
Site 128	Watson Martin Twp Landfill	15	3	25	0.7	10.88

00005451	Philip Mac Vean (LUST Site)	15	20	0	0.8	10.8
3000317	3130 110th Avenue	10	0	40	0.5	10.5
3000233	48th Street (345) E.	0	20	40	0.4	10.4
3000361	720 N. Main Street	1	0	50	0.8	10.4
Site 111	Un-named (Marsh Sand and Gravel property)	30	5	10	0.5	10.25
3000385	Lincoln (4392) Rd and M-40 (1724) Hwy	0	0	50	0.4	10
3000373	860 & 904 Interchange Rd & 1737 M-40	0	0	50	0.3	10
Site 115	Jack Norton Hauling Service	15	0	20	0.8	10
3000419	607 North Main Street, Plainwell	0	0	50	0.8	10
Site 118	Mead Paperboard(Type III SLF)	0	0	50	0.7	10
3000425	1107 Reno Drive & 1107 132nd Avenue, Way	0	0	50	0.7	10
3000198	Ebert Farm	10	60	25	0.2	9.6
3000240	M-40 Highway (1750), Holland	0	0	45	0.4	9
Site 94	Allegan County Landfill (Dobbins Landfill)	5	0	40	0.4	9
3000418	3404 12th Street, Wayland	10	10	20	0.6	8.8
00002753	Former Cook Auto (LUST site)	5	40	15	0.4	8.8
3000412	180 E. 40th Street, Holland MI 49423	10	25	0	0.7	8.75
3000220	Lynx Golf Course	0	0	40	0.9	8
00004067	Rai Phillips 66 Inc (LUST Site)	0	65	10	0.3	7.85
3000352	6673 126th Avenue	50	45	0	0.2	7.7
Site 99	Cheshire Township Disposal	5	0	25	0.7	6.75
Site 112	Hopkins Township Dump	5	0	25	0.6	6.5
3000012	Huitt and Sons	10	10	15	0.4	6.2
3000359	701 East 64th Street	0	0	30	0.5	6
Site 642	Misak Landfill (#08000011) / Yankee Springs Twp Dump (#08000022)	20	0	0	0.6	6
3000263	353 East 1st Street	7	15	10	0.5	6
00013332	Petro & Pantry II (LUST Site)	7	10	10	0.6	5.9
3000308	220 East Main Street	5	10	10	0.6	5.3
3000289	125 East Main Street	5	10	10	0.6	5.3
50002237	Former Fennville Filling Station (LUST Site)	5	10	10	0.6	5.3
00007401	Fennville Feed (LUST Site)	5	10	10	0.6	5.3
00009675	City of Holland School District (LUST Site)	15	0	15	0.3	5.25
3000274	1130 Lincoln Avenue	5	25	0	0.5	5
Site 1991	Hopkins Twp Landfill 22nd Street	15	0	10	0.4	5
3000026	Pullman East Oil Field	5	0	15	0.8	5

3000364	74th Street South Haven MI	10	0	17	0.3	4.9
3000375	875 Brooks Avenue	0	40	0	0.4	4.8
Site 88	A1 Disposal LF	3	0	20	0.4	4.6
3000376	905 Brooks Avenue	0	38	0	0.4	4.56
3000380	955 Brooks Avenue	0	35	0	0.4	4.2
3000377	942 Brooks Avenue	0	35	0	0.4	4.2
3000003	A 1 Disposal LF	0	0	20	0.4	4
3000363	741 Waverly Court, Holland	25	0	0	0.3	3.75
3000372	859 East 48th Street	25	0	0	0.3	3.75
00018914	The Little Store (LUST Site)	10	0	10	0.3	3.5
3000280	115 E. Fennville Street	5	5	0	0.8	3.2
3000411	5593 136th Avenue, Fillmore Township, MI	15	10	0	0.3	3.15
3000365	760 E. 40th Street	30	0	0	0.2	3
3000273	1128 58th Street	0	0	15	0.7	3
00016422	American Aerosols (LUST site)	20	0	0	0.3	3
3000402	City of Fennville	5	5	0	0.7	2.8
3000357	694 East 40th Street	17	0	0	0.3	2.55
3000242	Birds Eye Foods--AST Release	5	3	0	0.7	2.38
MID-006-411-953	BASF Corporation	0	10	0	0.7	2.1
3000408	694 East 40th Street, Holland MI 49423	20	0	0	0.2	2
3000339	471 East 40th Street	0	0	10	0.5	2
3000399	1162 Washington Avenue, Holland, MI 4942	0	0	10	0.3	2
Site 113	Huitt & Son	5	5	0	0.4	1.6
3000055	Res Wells 10th St	3	0	0	0.8	1.2
3000243	Washington Ave (1111, 1147), Holland	0	0	5	0.3	1
3000258	40th (636) Street, East	5	0	0	0.3	0.75
Site 178	KavCo SLF (KAV Company)	2	0	0	0.5	0.5
3000341	588 E. 40th Street	0	0	0	0.4	0

Recommended Next Steps

As previously emphasized, this “foundational” study represents the first critical step for the county toward managing its large number of point-sources (sites) of groundwater concern. The integration of numerous spatial datasets and groundwater modeling capabilities enabled characterizing in a relatively short time the

potential for groundwater transport and risk to critical groundwater receptors. This information can be used to guide the next steps of management and investigation, which may involve incorporating human and environmental health perspectives and updating the risk ranking/priority lists, as well as refining the groundwater modeling as more data become available and management priorities evolve (see **Error! Reference source not found.**).

Hydrosimulatics INC. recommends the following next steps, building on the efforts of this current study:

- ~~First: screening level modeling at additional/remaining sites of groundwater concern. The modeling and mapping approaches used in this study can be applied to other potential sources of groundwater pollution that were not part of the scope of work for this study. Approximately 60 Open LUSTs remain uninvestigated, and there were over 160 Underground Storage Tanks (USTs) identified at the time of the Phase 1 study. There are also dozens of oil and gas wells that, if leaky or fractured, may provide a vertical conduit for flow of deeper, highly mineralized groundwater to the near surface environment.~~

~~After these sites are analyzed, the risk ranking list should be updated to reflect the additional sites in the countywide portfolio. As additional work, Hydrosimulatics INC. is willing to complete the modeling and integrated analysis of additional sites, as well as make updates to the overall risk ranking list. COMPLETED AS DETAILED IN THIS ADDENDUM.~~

- Second: screening-level investigation of the contamination sources. A next important step is to determine nature of the sources at the sites of highest priority (or all sites where information is available), e.g., the type of substance or chemical(s) that are present, the timing and nature of the contamination event (e.g., continuous / “instantaneous” releases, current vs. historical, accidental spill vs. intentional discharge to the event, etc.), and the “strength” or severity of the contamination (i.e., how it was released at the property and the expected/observed concentrations in groundwater at the site). After determining the nature of contamination, it is possible to establish the risk to human health based on toxicology and risk exposure analysis (e.g., observed/expected concentrations vs. established health standards, consumption vs. skin exposure, acute vs. chronic exposure, etc.).

A “source risk rating” can be applied to all sites investigated and *a new weighted average can be developed to generate a new overall risk ranking list.* As additional work, Hydrosimulatics INC. is willing to work with the county to compile existing information related to the nature of the contamination sources, and to update the risk ranking list as needed.

- Third: data collection and focused modeling at high-priority sites (for the updated risk ranking lists). In some cases, data/information related to the nature of the contamination may not be available, or additional information is needed to determine the source risk rating. Collecting groundwater quality data on- and off-site may be necessary to assess the environmental conditions and develop a mitigation strategy. Also useful are physical groundwater data (water levels and borehole lithologies) from precise groundwater monitoring wells that can be used to better constrain a calibrated model compared to regional SWL data used for calibration⁴.

⁴ Recall that the regional models developed for this study are calibrated to Wellogic data, which is suitable for regional calibration, but are too “noisy” (uncertain) to be use for detailed site-scale calibration and transport modeling.

The calibrated models developed for this study can be improved or extended as more data/information is collected and the need to address limiting assumptions of the screening-level models becomes important. Additional information that can be incorporated into existing groundwater models include: geologic data (borehole lithologies) that be used improve the conceptual model at the site (e.g., the 3D subsurface structure or small-scale heterogeneities at the site); operational pumping rates, especially for large-capacity public supply wells⁵; groundwater level data that can help refine model parameters such that model outputs better match observed data (this is particularly relevant for site-scale models); and groundwater chemistry (water quality) data for mapping the real 3D extent of the plume. The calibrated/refined site-scale models can then be applied to “full” fate and transport modeling, i.e., simulating chemical concentrations as a function of space and time, accounting for source properties/dynamics and the biogeochemical properties of the substance of interest (e.g., PFAS). A full, 3D transport model can be used to design and optimize a remediation process such as extraction wells or trenches for a pump-and-treatment operation.

A further aspect of focused modeling at high-risk sites is model sensitivity analysis. This technique can be used to evaluate the impact of uncertainty of model parameters on predicted outcomes (e.g., water levels and flow patterns, plume path and direction). Groundwater properties such as hydraulic conductivity, porosity, and recharge can vary significantly across space, and a number of combinations of plausible parameter values may satisfy model calibration to observed data. The idea with sensitivity analysis is to change the model input parameters within the likely ranges of values (based on the geological/environmental setting) and evaluate the variability of the model in response to changes to input parameters. This gives managers a sense of the possible outcomes based on the information available.

Finally, the modeling approaches used in this study can be applied to delineate impact areas beyond the 20yr. horizon (e.g., 30 or 40 years of assumed travel time) to help facilitate even longer-term planning. This may also help evaluate the present-day impact of legacy contamination events (e.g., spills that occurred more than 20 years ago).

As additional work, Hydrosimulatics INC. is willing to perform focused modeling at high-priority sites and assist the county with creating a data collection plan at these sites.

- Fourth, cleanup and remediation. Based on the holistic understanding of hydrogeology and human health risk, some sites may require “immediate” action to mitigate or eliminate the groundwater contamination. In these cases, the first step is to establish liability (who will pay for cleanup?) and a process for oversight (e.g., working with the State of Michigan or US Environmental Protection Agency to secure funding and the necessary technical expertise). As previously stated, Hydrosimulatics can perform focused modeling at high-priority sites to assist in the design and optimization of site-specific remediation systems.

⁵ Pumping was not represented in the calibrated regional models, although drawdown from pumping may have localized impacts on the regional flow patterns, which can be important for “active” capture of nearby groundwater plumes.